Scientific Basis for Flow Control

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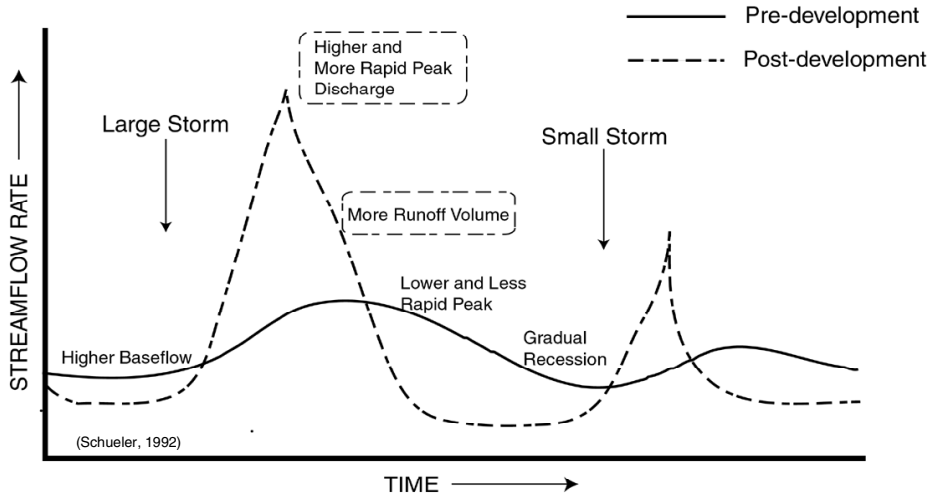
Objective

The purpose of flow control is to mitigate to the maximum extent practicable the impacts of increased storm runoff volumes and flow rates on streams in eastern Washington. The intent is to prevent cumulative future impacts from urban runoff; the impacts of prior development and/or flow modifications in eastern Washington are not addressed. Conveyance and flood protection requirements are established by local jurisdictions.

Background

Just as the landscape of eastern Washington includes prairies, pine forests, the shrub-steppe, channeled scablands, and vast areas of irrigated and dry land agriculture, the hydrology of streams in eastern Washington varies tremendously. Regardless of the hydrologic and geologic setting, streams can be impacted by urbanization of their watersheds. As development occurs, land is cleared and impervious surfaces such as roads, parking lots, rooftops, and sidewalks are added. The natural soil structure is altered by grading and compaction during construction and loses the ability to infiltrate, hold and slow runoff. Local natural drainage patterns may be irrevocably altered and shortened to accommodate development infrastructure. The accumulation of these changes affect the natural hydrology by increasing the peak flow rates of runoff; increasing the total volume of runoff; decreasing the time it takes for runoff to reach a natural receiving water; and increasing stream velocities. The figure below illustrates some of these changes.



As a consequence of these changes in hydrology, stream channels may experience both increased flooding and reduced base flows. Natural riffles, pools, gravel bars, and other areas may be altered or destroyed. Increased channel erosion, loss of hydraulic complexity, degradation of habitat, and changes in the composition of species present in receiving waters may follow. These changes do not result from any one project; they are the cumulative effect of all development in a watershed.

From a stream morphology standpoint, smaller flood events that approximate bankfull conditions and occur naturally once or twice a year (1.5 to 2-year frequency) are the most influential discharges and most easily affected by added urban runoff. These smaller flood events shape the channel and are referred to as "effective flows" because over time they move the most sediment and transform the dimensions of a stream channel. When effective flows increase in size, duration and frequency the most common impact is changes in channel morphology to accommodate the rise in erosive energy delivered to receiving streams on an annual basis.

Flow Control Standard for Eastern Washington

Although specific data and studies for eastern Washington are not currently available, research in streams in arid, semi-arid and humid climatic settings has shown that this accommodation commonly takes place by widening and downcutting of the streambed, damaging habitats and potentially reducing biologic diversity. Erosion problems from an aquatic ecosystem perspective are much more subtle than from an engineering perspective: streambank undercutting and failures occur long after changes to the habitat function of the streambed.

When comparing the pre-development (or existing) hydrograph with the post-development hydrograph, the concern is not limited to the peak flow events. Mitigating the *duration* of the flood flows is also important for stream channel stability and habitat. Historic flow control measures have focused on controlling runoff by matching the pre- and post-development peak flow rates. This does not adequately address the increased duration at which those flows occur because the volume of runoff is greater than the pre-development condition. Detention basins that only match peak runoff rates contribute more water to a stream over time and extend the length of time the peak discharge rate is at work, moving sediments in the streambed. The approach of only matching the peak flow rates fails to protect stream habitats from increased erosional energy.

To protect stream channels from increased erosion, it is necessary to control the durations over which a stream channel experiences geomorphically significant flows (flows that are capable of moving sediments) such that the energy imparted to the stream channel does not increase significantly. For most streams, these flows are within the 1.5- to 2-year range of recurrence intervals. If the pre-development 2-year peak runoff rate is met for the entire 2-year post-development runoff volume, the stream experiences that flow rate for a longer period.

Releasing the post-development 2-year runoff volume at half of the pre-development 2-year peak flow rate reduces the total erosional energy to somewhat nearer to that of the pre-development condition. This may be over-protective for streams with less erodible bed materials such as clay, or under-protective for streams with very erodible bed materials like sand or loess, but the target provides a standard that will be protective in most cases and is easily applied to most projects. This approach to flow control is targeted to smaller water bodies, which are most susceptible to the changes in runoff patterns caused by development. The *Final Draft Stormwater Management Manual for Eastern Washington* includes a list of larger streams that are exempt from flow control.

In many cases the two-year pre-development flow rate is so small that it is impracticable to design a pond to release runoff at the prescribed flow rate from an engineered outlet structure. In these cases the total post-development 2-year storm runoff volume should be infiltrated (preferred) or stored in a retention pond for evaporation.

A number of proven and emerging "Low Impact Development" (LID) techniques may be applied to reduce impervious surface areas and minimize the need for flow control at a project site. See Ecology's, the U.S. Environmental Protection Agency's or the Puget Sound Water Quality Action Team's websites for additional information about LID approaches and links to demonstration projects and research activities.